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PENSOFT

First record of *Macrocybe titans* (Tricholomataceae, Basidiomycota) in Argentina

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Abstract
Macrocybe titans is characterized by its basidiomata with a remarkable size, the squamose stipe surface, and the pseudocystidia with refractive content. In this paper, we describe and analyze the macro and microscopic features of Argentinian collections of this species, and provide photographs of its basidiomata and drawings of the most relevant microscopic structures. In addition, we present a map with the American distribution of *M. titans*, highlighting the first record of this species for the country.

Key words
Agaricales, Fungi, *Tricholoma titans,* Neotropics, taxonomy.

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Introduction

The genus *Macrocybe* Pegler & Lodge was described by Pegler et al. (1998) to accommodate tropical and subtropical species not included in the *Tricholoma* sensu stricto clade. It is characterized by its large, saprotrophic, tricholomatoid species, and has abundant clamp connections, but it lacks siderophilous granulation in its basidia (Pegler et al. 1998). The morphological and ecological data, considered together with molecular analyses made by Pegler et al. (1998) support that *Tricholoma titans* falls outside the *Tricholoma* sensu stricto clade, and the placement of *T. titans* in the genus *Calocybe* (tribe Lyophylleae) is also not strongly supported. Later, Moncalvo et al. (2002), through phylogenetic analyses of the nuclear large ribosomal subunit gene (nLSU), confirm that *Macrocybe*, *Callistosporium* Singer, and *Pleurocollybia* Singer, constitute the callistosporioid clade.

Macrocybe is characterized by the tricholomatoid habit of its basidiomata, often forming connate or caespitose clusters; pileus surface white, cream to grayish-ochraceous; basidiospores subglobose to broadly ellipsoid and smooth; basidia lacking siderophilous granulation; pileipellis well developed, with a repent cutis of thin-walled hyphae; clamp connections always present; gymnocarpic development; and saprotrophic habit (non ectomycorrhizal), which differentiate it from other genera as *Megatricholoma* G. Kost and *Tricholoma* (Fr.) Staude (Pegler et al. 1998).

Macrocybe is represented by 7 species of pantropical distribution, being *M. titans* (H.E. Bigelow & Kimbr.) Pegler, Lodge & Nakasone and *M. praegrandis* (Berk.)

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Pegler & Lodge the only American species (Pegler et al. 1998). One of these, *M. titans*, has been studied from taxonomic descriptions of some American countries (e.g. Corrales and López-Quintero 2005, Calonge et al. 2007, Battistin and Picciola 2015), to determination of chemical and biochemical profile (Saika 2008) or the production of amylolytic enzymes in brewing residue (Wisniewski et al. 2010).

In Argentina, there are no records of *Macrocybe* to date. Thus, the aim of this work was to describe *M. titans* based on the Argentinean collections.

Methods

The specimens were collected in Corrientes province, Argentina, and they were photographed and described macroscopically in situ. For taxonomic identification the specimens were analyzed macro- and microscopically following the criteria and terminology proposed by Largent (1986), Vellinga (1988), and Lodge et al. (2004). The color terminology follows to Kornerup and Wanscher (1978). Freehand cuts were made for the microscopic analysis (e.g. elements of the pileus surface, context of pileus and stipe, basidiospores, basidia, cystidia) and mounted in KOH 5% (v/w) solution with aqueous Phloxine 1% and Melzer's reagent (Wright and Albertó 2002). Microscopic structures were measured directly with immersion objective 1000× or through photographs taken with built camera Leica EC3 using the software Image Pro Plus® 4.0. Minimum–maximum intervals are provided for the different microscopic structures, separated by an en dash. For the spores, the average value (x), Q coefficient (length / diameter), mean value of Q (Qx), number of spores counted (n), and the number of basidiomata of which were the spores measured (N) are also provided. Authors of scientific names are according to the Index Fungorum, Authors of Fungal Names (2016), and herbarium acronyms are according to Thiers (2016). The collected material was dried, kept in freezer for a week and was deposited as reference in the CTES Herbarium.

Results

Macrocybe titans (H.E. Bigelow & Kimbr.) Pegler, Lodge & Nakasone, *Mycologia* 90(3): 500 (1998). Figures 1–7.

≡ ***Tricholoma titans*** H.E. Bigelow & Kimbr. *Mycotaxon* 11(2): 426 (1980).

Pileus 4.1–15.3 cm broad, convex at first but soon becoming broadly convex or plane, disk somewhat depressed in age, surface cream to pale yellow (3A3–4A3), dry, not hygrophanous, cracking when dry, squamulose towards the margin with slightly darker scales (4B3, grayish yellow), margin incurved at first, uplifted in mature specimens, slightly undulate or lobate. **Context** thick at disk (up to 1.5 cm), thinner towards the margin (up to 0.3 cm thick), whitish (2A2–2A1). **Odor** strong mushroom-like, **taste** not tested. **Lamellae** crowded, sinuate to adnate with a decurrent tooth, moderately broad (up to 1 cm broad), yellowish grey to cream (2B2–3B2), edge entire, with lamellulae of 4 lengths. **Stipe** 4.7–23 × 1.1–3.2 cm, cylindrical to clavate, up to 3.6 cm diameter at base, solid, surface pale yellow (4A3) with numerous and reflexed squamules, dark brown (5F6–6F5). **Annulus** absent. **Volva** absent. **Spore-print** cream.

Basidiospores 4.5–6.6 × 4–5.5 µm, x = 5.7 × 4.5; Q = 1.02–1.39; Qx = 1.26; n = 60; N = 2, subglobose to broadly ellipsoid, thin-walled, smooth, hyaline, inamyloid, without germ pore, containing a single guttule which covers much of the surface. **Basidia** 27.7–42 × 6–7.3 µm, subcylindrical to narrowly clavate, 4-sterigmata, with a basal clamp connection, extended to the lamellar edge. **Pleurocystidia** of pseudocystidia type, 34.6–45 × 8.2–14 µm, broadly fusiform, narrowly lageniform to narrowly utriform, with a distinctly rostrate apex slightly protruding beyond basidia, thin-walled, smooth, with refractive content, abundant but scattered. **Cheilocystidia** like pleurocystidia, but larger, 32–54 × 7.1–17 µm, scattered, not forming a continuous sterile band. **Hymenophoral trama** regular, hyphae short cylindrical, up to 13 µm broad, hyaline, with clamp connections. **Pileipellis** a cutis of repent, narrow hyphae, up to 5 µm broad, hyaline, thin-walled, interwoven, often branched, with clamp connections.

Material examined. Argentina, Corrientes, Capital, Campus Universitario Sargento Cabral, solitary, growing in sandy soil below *Delonix regia* (Bojer) Raf. (27°27′34.47″ S, 058°49′21.37″ W, 64 m a.s.l.), 9/III/2015, leg. N. Ramirez and N. Niveiro NR 99 (CTES 0568348); same loc. 15/III/2003, leg. O. Popoff 3711 (CTES 0568347). Mercedes, Laguna Iberá, Paso Picada, in marginal forest, (28°32′13″ S, 057°11′11″ W, 67 m a.s.l.), 26/II/1989, leg. S. Tressens 3762 (CTES 0568346).

Discussion

Macrocybe titans is macroscopically characterized by the remarkable size of its basidiomata and the squamulose stipe surface, and microscopically by the numerous refractive pseudocystidia (Pegler et al. 1998). This species was originally described by Bigelow and Kimbrough (1980) from Florida (USA) as *Tricholoma titans*. In their description, these authors mentioned a pileus from 2.5 to 75 cm in size (Bigelow and Kimbrough 1980) and later Pegler et al. (1998) described it from 8 to 100 cm broad. However, the largest specimen here examined does not exceed 16 cm broad, so the size range of the Argentinian material, like the Brazilian specimens (Battistin and Picciola 2015), coincides with lower values known for this species.

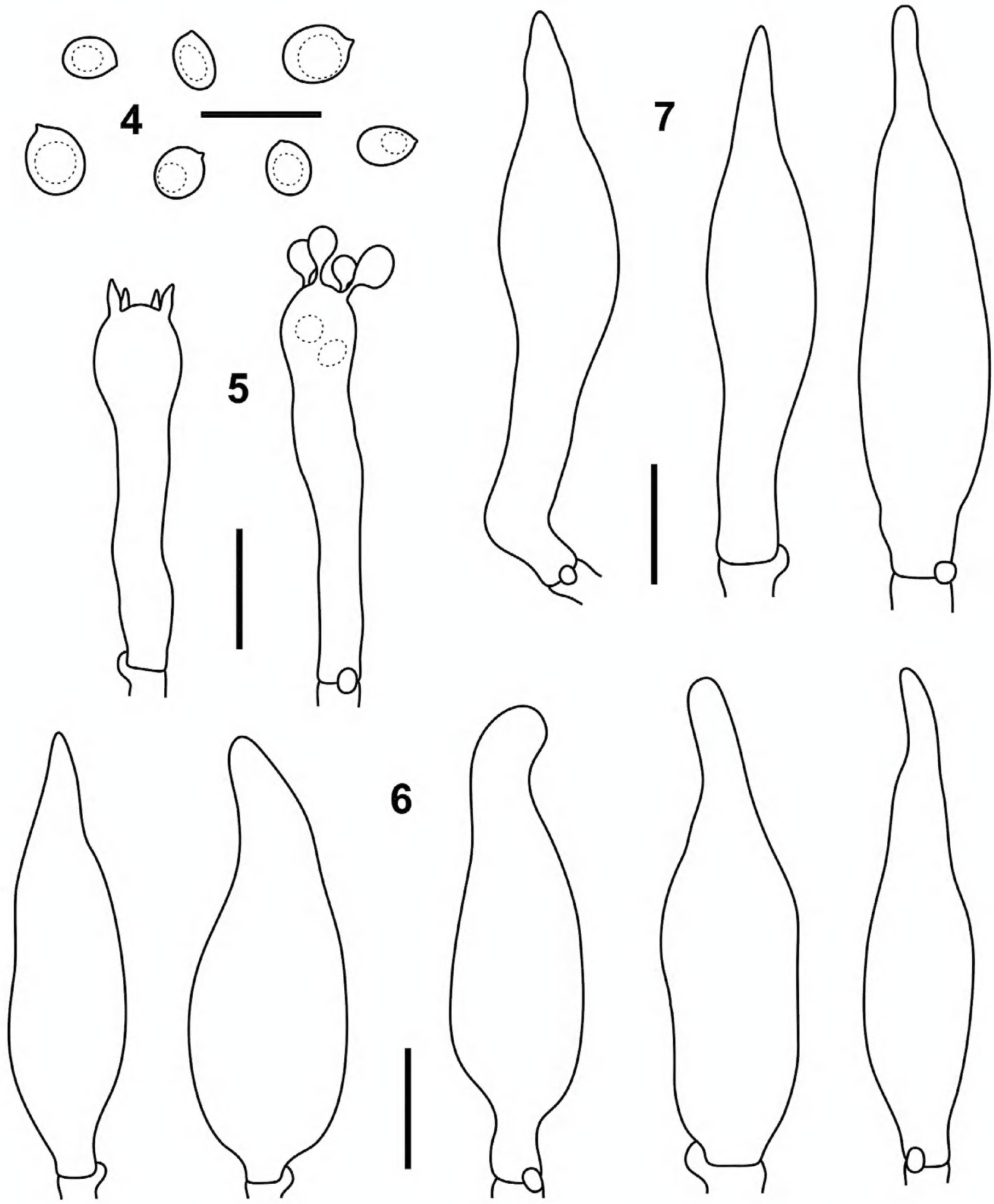
Macrocybe pachymeres (Berk. & Broome) Pegler & Lodge is the most morphologically similar species to *M. titans*. It was cited for Sri Lanka and India and it has similar macroscopical features like the pigmentation and the squarrose stipe surface. Pegler et al. (1998) contrasted both species only by the presumable absence of pseudo-

Figures 1–3. Specimens of *Macrocybe titans* [Ramirez and Niveiro, NR 99 (CTES)]. **1.** General aspect of basidiomata. **2.** Detail of squamules. **3.** Detail of lamellae. Scale bars = 30 mm. Photographs by N. Niveiro.

cystidia with refractive content in *M. pachymeres*, and preferred to keep them as different species by the wide geographical distance between both. However, Vrinda et al. (1997) described material of *M. titans* from India, near to the type locality of *M. pachymeres* (Pegler et al. 1998), with pleurocystidia and squamulose stipe. Therefore, it is very probable that both species are conspecific, and the pleurocystidia in the type of *M. pachymeres* are just not conserved. It is important to consider that in this case, being both synonymous, *M. pachymeres* should be the correct name for this species due to the principle of priority (McNeill 2012). Nevertheless, additional studies are needed to confirm this hypothesis.

The other American species of the genus is *M. praegrandis*, described from Minas Gerais and São Paulo States in Brazil, which resembles the Argentinian specimens of *M. titans* in its habitat, size, and coloration, but differs in its stipe with a swollen base and a smooth surface (Pegler et al. 1998).

It is important to point out that *M. titans* is a species that is currently being focus of numerous applied studies as enzymatic production and mushroom culture (Stijve 2004, Wisniewski et al. 2010, Cotter 2015), which gives more interest to the Argentine collection, because the natural conditions are present so that this species can be large-scale cultured (Calonge et al. 2007).



Figures 4–7. Microscopic characters of *Macrocybe titans* [Ramirez and Niveiro, NR 99 (CTES)]. **4.** Spores. **5.** Basidia. **6.** Pleurocystidia. **7.** Cheilocystidia. Scale bars = 10 µm. Drawing by N. Ramirez.

Macrocybe titans has a pantropical distribution, with several records in tropical and subtropical northern hemisphere of America (Pegler et al. 1998) and Asia (Vrinda et al. 1997, Chen and Chen 1999, Farook et al. 2013). In America, it was originally described based on material from southern USA (Bigelow and Kimbrough 1980) and then recorded from Mexico (Cifuentes and Guzman 1981, Singer 1990), Costa Rica (Pegler et al. 1998, Corrales and López-Quintero 2005, Calonge et al. 2007), Colombia (Corrales and López-Quintero 2005), Ecuador, Martinique, Puerto Rico, Trinidad and Venezuela (Pegler et al. 1998). In addition, it was recently recorded from southern Brazil (Battistin and Picciola 2015), which together with this record in Argentina, indicates that this species has a larger distribution, in the southern hemisphere reaching similar latitudes as in the USA (Fig. 8). Even though apparently *M. titans* is restricted to the Neotropics, Chen and Chen (1999) described it from the

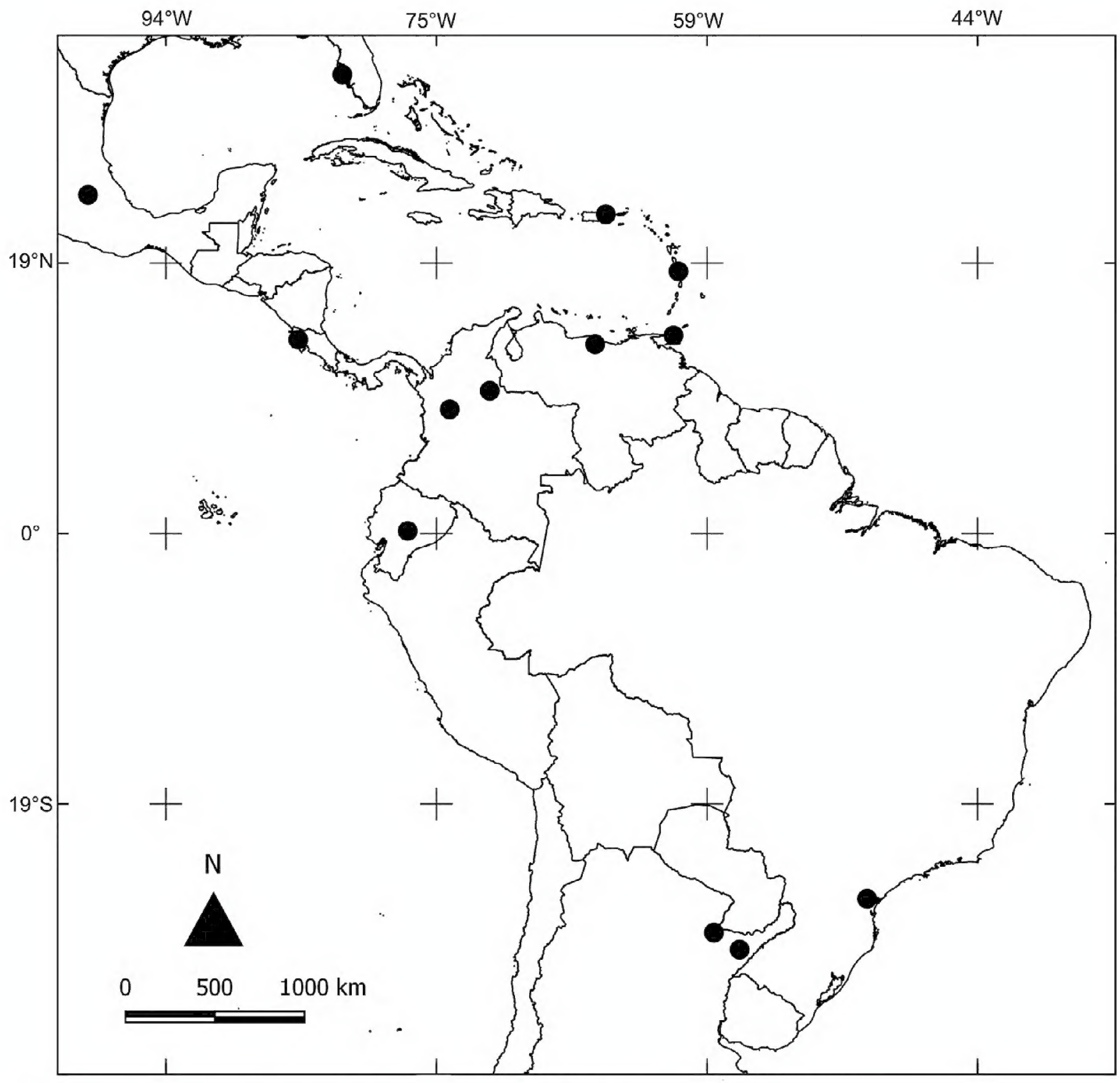


Figure 8. Distribution of *Macrocybe titans* in America. Map by N. Niveiro.

Taichung (Taiwan), and Vrinda et al. (1997) and Farook et al. (2013) recorded it from the Kerala state (India), which would indicate that is a pantropical species. The new record presented here represents the southernmost locality of this species and the first record of the genus from Argentina.

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Authors' Contributions

NR, OP and NN collected the specimens and identified the collections, NR and AM wrote the text and made the illustration, NN produced the map, NN and OP revised the manuscript.

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